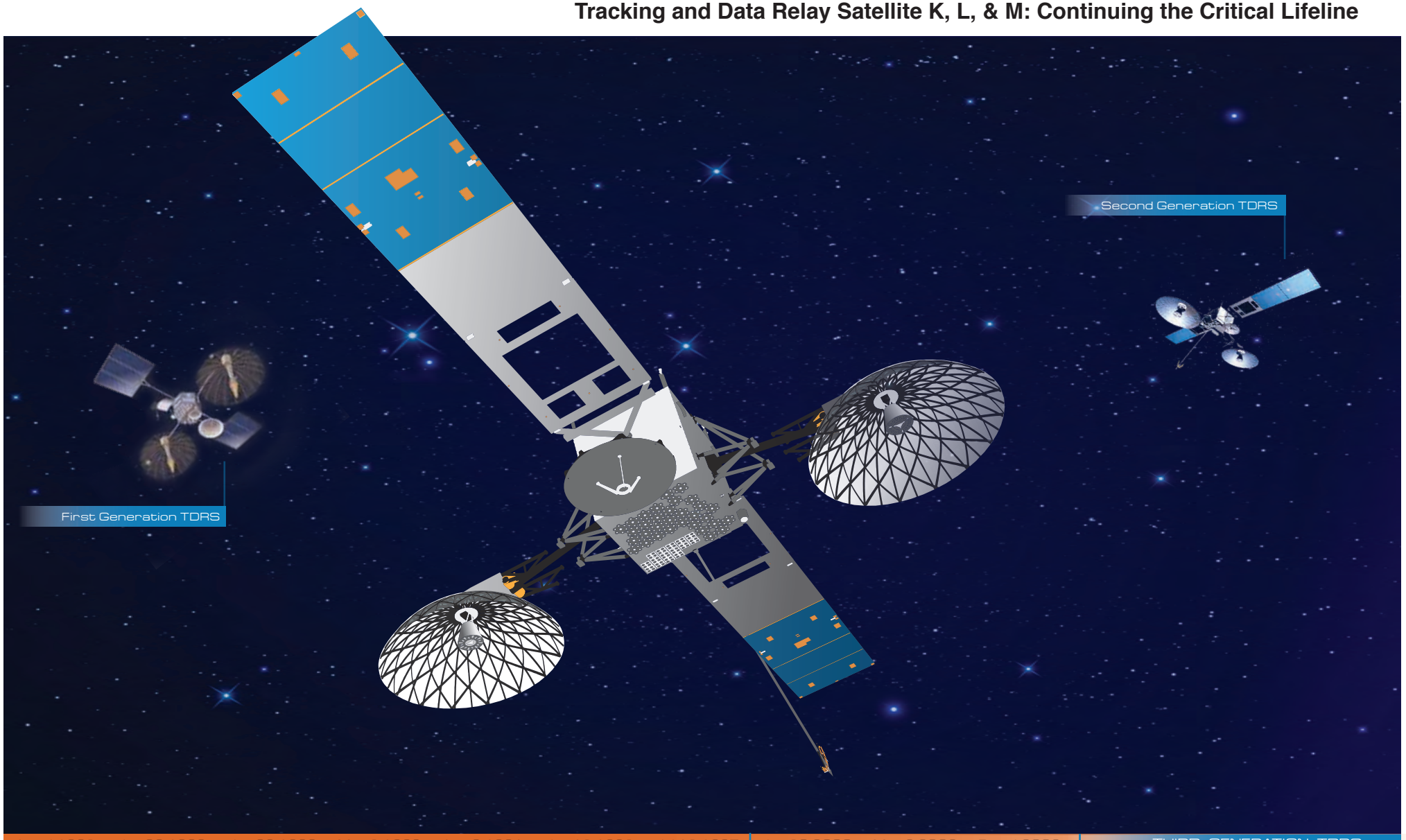
National Aeronautics and Space Administration

Tracking and Data Relay Satellite K, L, & M: Continuing the Critical Lifeline



Apr 4 1983	Jan 28 1986	Jan 29 1988	Mar 3 1989	Aug 2 1991	Jan 13 1993	Jul 13 1995	Jun 30 2000	Mar 8 2002	Dec 4 2002	. . . THIRD GENERATION TDRS
TDRS A	TDRS B*	TDRS C	TDRS D	TDRS E	TDRS F	TDRS G	TDRS H	TDRS I	TDRS J	TDRS K, L, M

*Lost in the Challenger accident

First Generation TDRS

Second Generation TDRS

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TRACKING: To observe or plot the path of a moving object, such as a satellite. **DATA:** Information, in the form of Binary Code, that can be transmitted through space and read by satellites and ground stations. **RELAY:** The act of passing something along (such as data) from one person or system to another. **SATELLITE:** An object that is orbiting around another larger object.

The **Tracking and Data Relay Satellite, (TDRS,)** is NASA's "communicator" in space. Placed in geosynchronous orbit over the Earth's equator, a constellation of TDRS spacecraft provide communication links between scientific satellites flying in low-Earth orbits (LEO) and ground terminals located in New Mexico and Guam. Scientific data from LEO satellites, such as images from the Hubble Space Telescope or from experiments on the International Space Station, are beamed up to TDRS, which take the data and transmit it to Earth where researchers can process and interpret the information. Similarly when researchers would like to command their satellites to do something, for example to turn on a telescope or to point in a certain direction, they send these commands up from Earth through a TDRS that relays them to their satellite. With TDRS spacecraft grouped into three positions around Earth (Atlantic, Pacific and Indian Ocean), a satellite always has a TDRS to communicate with. TDRS is available 100% of the time satellites need to "phone home".

8. **The second solar array is deployed, enabling the Omni antenna to deploy and the Space-to-Ground link antenna to lock into place. Now the TDRS is ready to receive and transmit commands and data from over 20 spacecraft orbiting Earth.**

7. **Now that the first solar array has been deployed the two Single Access antennas are able to completely deploy and be locked into place.**

6. **Now that TDRS has reached geosynchronous orbit, deployment of the six folded parts can begin. The first of two solar panels is deployed, and captures solar energy that will power all of the spacecraft's onboard electronic systems.**

5. **Quickly following detachment TDRS's two SA antennas, which have been furled together, are released but not completely deployed because the solar panels need to be in place first. Over the next 11 days the TDRS on-board rocket powers the spacecraft to its final orbit.**

4. **After boosting the spacecraft to geosynchronous transfer orbit, the centaur engine detaches.**

3. **Shorty after seperation from the booster, the two halves of the spacecraft's protective capsule (fairing) seperate and the centaur engine ignites driving the TDRS to geosynchronous transfer orbit.**

2. **About four minutes after lift-off, the booster rocket seperates from the centaur engine and drops back to Earth.**

1. **LIFTOFF!**

Geosynchronous Orbit

TDRS spacecraft are placed about 22,300 miles/36,000 km above the Earth, where the time it takes to complete a single orbit around the Earth is 24 hours. This is called a geosynchronous orbit since it is "synchronized" with the spin of the Earth. By being in synch with the Earth's rotation the satellite appears to stay motionless in the sky. This allows TDRS to be continuously supported by a single ground station location.

Why is this important to communications?

Since TDRS is located in a geosynchronous orbit, it will be in view of a ground station all of the time. This means that TDRS can receive commands to pass onto other satellites and/or send data from other satellites to Earth, 24 hours a day, 365 days a year.

OMNI ANTENNA

The TDRS omni-directional (omni) antenna provides an emergency, low data-rate link to the ground. The Omni antenna has a very wide beam, hence the name omni-directional, which allows it to send its signal to a wide area. When the SGL antenna signal is reduced by rain, or if it is not pointed properly, the omni antenna is able to transmit communications to and from the ground station.

MULTIPLE ACCESS ANTENNA

The Multiple Access (MA) antenna system is actually a collection of more than 40 small antennas that work together transmitting data from multiple satellites simultaneously. The MA antenna system allows satellies like the Fermi Gamma Ray Observatory to immediatley transmit an alert message to the ground if a gamma ray burst is detected.

SINGLE ACCESS ANTENNAS

The Single Access (SA) antennas are the two large 4.6m diameter dish antennas included on the sides of each TDRS. Each SA antenna can be used to communicate with a low-Earth orbit scientific satellite at a given time. SA antennas can be steered so that they keep a LEO satellite in their beam as it passes below them.

SPACE TO GROUND LINK ANTENNA

The 1.8m diameter Space-to-Ground Link (SGL) antenna is the communication link between TDRS and the ground. Data collected from LEO satellites via the SA and MA antennas is sent to the SGL antenna for transmission to the ground. Similarly, all commands from LEO satellite controllers on the ground are first uplinked to the SGL antenna, which then sends the command to the MA and/or SA antennas for final routing onto the desired LEO satellite. SGL antennas send/receive data from ground stations located in either White Sands, NM - if the TDRS is located above the Pacific or Atlantic Oceans - or from Guam if they are located over the Indian Ocean.

SOLAR ARRAYS

Sending and receiving data from LEO satellites, while maintaining a communications link with the ground, takes a lot of electrical power. The two 7.6m long solar arrays on each TDRS, are able to generate over 3,000 watts of energy. That's enough to power 300 game consoles at once! It also enables the TDRS spacecraft to succesfully relay user spacecraft data 24 hours a day, 365 days a year.

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